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### Remarks on the current issue:

Revision: Definitions in Para. 3 and scope of work in Para. 4 revised; Awareness training in Para. 6 added; Workflow in Para. 11 added; Tables 1 and 2 revised; Form 03 new; Editorial revised.

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Responsible department(s) for the technical content: GCEQ, ENQ

X	06	09.2016	Hempel, GCEQ	Dr. Hock, ENQ Dr. Pelz, DQ	Jatz, GCEQ
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## 1 Scope

This Linde Standard (LS) defines cleanliness requirements, cleaning methods, inspection/verification methods and acceptance criteria for ASU- and cold box process piping as well as for flat bottom tanks fabricated at Construction Sites.

The LS includes process from material delivery up to handover to commissioning at Construction Sites according to workflow.

## 2 Informative references

ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
SNT-TC-1	Personnel qualification and certification in nondestructive testing
LS 141-76	Oxygen service, Visual cleanliness inspection guide, Bright light and UV light

## 3 Abbreviations and definitions

ASU	Air Separation Unit
LINDE	Linde AG, Engineering Division
COMPANY	Party responsible for Construction Management
CONTRACTOR	Party responsible for construction work
Construction Site	Site for prefabrication or field assembly as well existing plants where construction work is carried out
Oxygen service	Service requirement applicable for cleanliness class S4 to S1
UV	Ultraviolet (black light)

## 4 Scope of work

LINDE	- definition of cleanliness requirements and acceptance criteria
COMPANY	- verification and acceptance of process component cleanliness.
CONTRACTOR	- preparation of cleaning procedure, based on requirements defined in this LS; - surface treatment of piping/tank to achieve required degree of cleanliness; - inspection of achieved cleanliness during fabrication, prior and after installation; - preservation of piping/tank during storing, transport, installation until mechanical completion.

## 5 Qualification of CONTRACTOR – only for piping systems

CONTRACTOR nominated for cleanliness inspections requires a LINDE procedure qualification to represent knowledge and competence.

CONTRACTOR has to demonstrate:

- cleaning and
- inspection

of first prefabricated spools (see Table 1 to 3) in the presence of COMPANY. The selected spools should reflect a typical spool of piping system. Equipment, machines and cleaning agents will be checked during these activities.

The mentioned procedure has to performed for each material (ferritic steel, austenitic steel and aluminium).

## 6 Qualification of inspection personnel

Personnel nominated for cleanliness inspections do not require a formal qualification however the inspection personnel shall have the awareness for the required cleanliness of components and equipment dedicated to oxygen service. Adequate industrial experience and LINDE oxygen awareness training – construction site shall be available with inspection personnel, incl. familiarisation with the cleaning and inspection methods applied with related criteria. Inspection personnel shall attest their vision qualification (eyesight test) according to a recognized standard e.g. ISO 9712, SNT-TC-1A or equivalent.

## 7 Inspection

### 7.1 Visual inspection with white-light

This method will detect without magnification small particulate material (larger than 50µm) such as dust, oil, grease and moisture. It may be used in conjunction with other methods. A sufficiently bright level of artificial or natural light is important.

### 7.2 Visual inspection with UV-light (black light)

This test shall be used always in combination with a white light inspection.

An UV-light with a wave length between 320nm - 370nm shall be used in dark or near darkness at a distance of about 10cm - 20cm from the surface or piece being examined.

Note: Not all hydrocarbons or organic oils fluoresce under UV-light. The method might indicate the need for other tests such as wipe test.

### 7.3 Wipe test

This test is used to detect contaminants on visually inaccessible areas. It is useful when bright white light inspection and/ or UV light inspection has been inconclusive or not possible. The surface is rubbed lightly with white filter paper or with clean lint-free cotton or linen cloth. This paper or cloth is examined under white light and/or UV light to find any contaminating traces. Several areas of the parts surfaces shall be tested in particular at edges and corners. Since it is not acceptable to leave cloth or paper particles on the equipment, this method is not suitable for rough surfaces.

### 7.4 Pig inspection

This method is used for the inspection of piping spools or assembled lines, which cannot be examined with a wipe test. The inspection is performed analogue to the Pig cleaning process, pulling a pig (covered with white lint free cotton or linen cloth) through the pipe/spool followed by visual white light inspection of pig resp. additional UV-light inspection.

## 8 Handling of non-accepted cleanliness

If an inspection reveals the presence of non-acceptable contamination, with oil or grease, residues of cleaning agent, or particles, the component shall be partially or even completely re-cleaned until acceptance criteria according table 1 and 2 are met.

## 9 Documentation

Cleaning, inspection and preservation shall be documented by CONTRACTOR per

- piping spool in oxygen service (prefabrication / installation)
- valve in oxygen service (material receiving / installation)
- flat bottom tank in oxygen service (installation / after hydrostatic test)

using the "Cleanliness acceptance report" acc. to Form 01 / Form 02 (see annex A).

COMPANY shall be invited for verification of cleanliness and review of relevant documentation in the course of progressing construction.

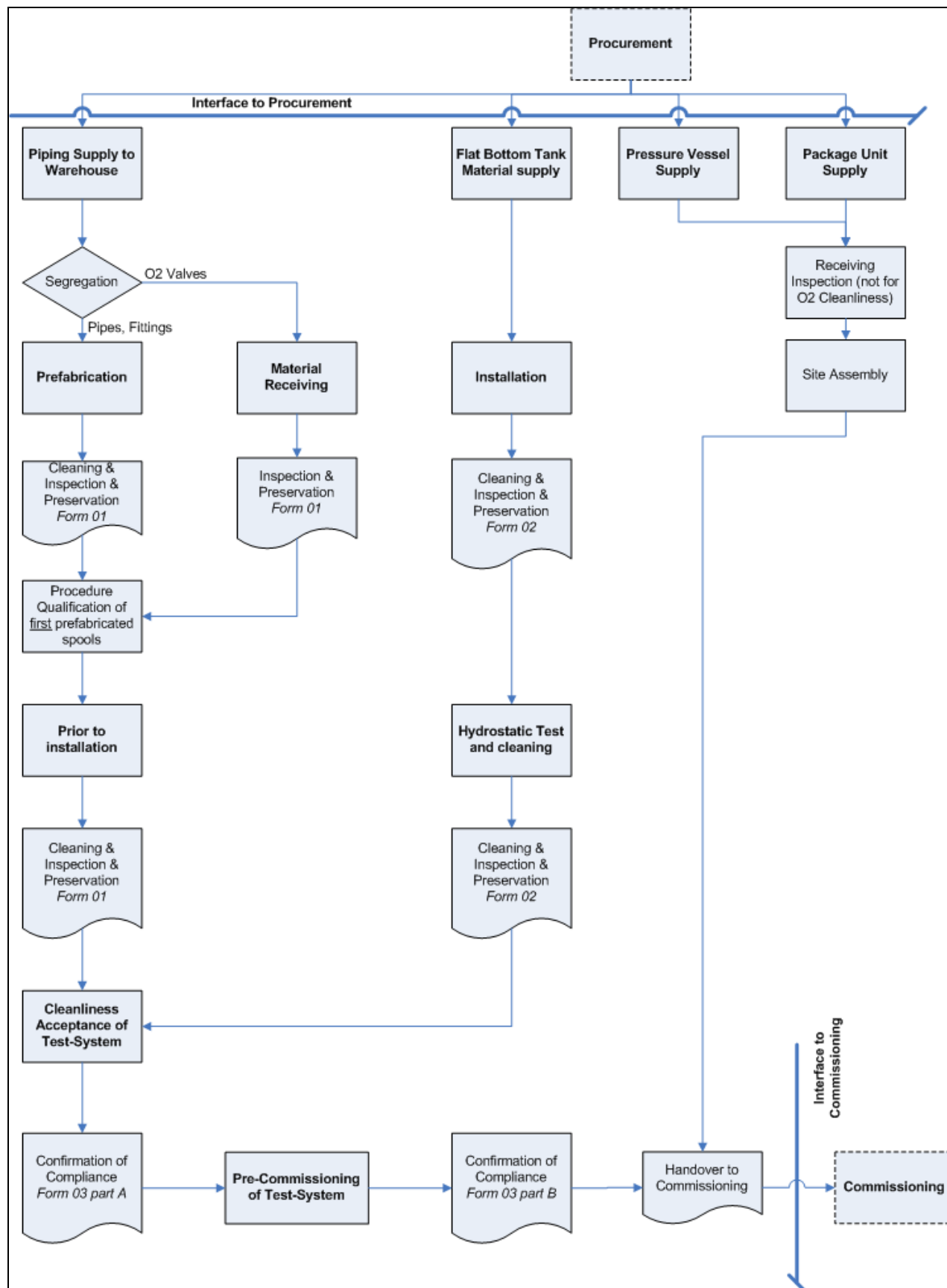
For process piping as well as flat bottom tanks for oxygen service erected at Construction Site, the compliance with this LS shall be certified by CONTRACTOR(S) in Form 03 (see annex A).

Documentation of cleanliness and inspection activities for components not belonging to oxygen service shall be agreed project specific.

## 10 Requirements for tank CONTRACTOR

If CONTRACTOR is responsible for piping at tanks, the procedure for piping has to observe (see workflow and Table 1 to 3).

## 11 Workflow



**Table 1: Cleaning and inspection of process piping for cleaning class S2**

Fabrication sequence / Components	Cleaning		Inspection		Acceptance criteria See also LS 141-76	Preservation	Documentation
	Ferritic steels	Austenitic steels, Aluminium	Ferritic steels	Austenitic steels, Aluminium			
Material Receiving Valves	-----		<ul style="list-style-type: none"><li>• 100% Visual white-light inspection <sup>2)</sup></li><li>• 100% Visual UV-light inspection <sup>2)</sup></li><li>• Wipe test in case of doubts <sup>2)</sup></li></ul>		No visible traces of: <ul style="list-style-type: none"><li>• organic material such as oil, grease, paint, etc.,</li><li>• cleaning agents, detergents,</li><li>• rust and loose scale, weld spatters, particles dust, fibres or other foreign materials.</li><li>• moisture, liquids</li></ul> Accumulation, i.e. a local concentration of particles of any size is not acceptable UV-light inspection shall not reveal any indications of oil/grease	Protection of openings with plastic caps/plugs, resp. plastic foil and tape	Form 01
Prefabrication Piping parts (pipes, fittings, etc.) Piping spools	Grit blasting <sup>1)</sup> for ≥DN100(NPS 4) (oil free, dry air/grit)	High pressure steam cleaning/degreasing (degreasing agent may be required) followed by dry air blowing  For ≤DN100 (NPS 4) alternatively “pig cleaning process” <sup>1)</sup>	<ul style="list-style-type: none"><li>• 100% visual white-light inspection</li><li>• 100% Visual UV-light inspection</li></ul>				Form 01
Prior to Installation Piping spools and valves	Blowing out with oil free, dry air or nitrogen (requires strict observance of safety regulations) and/or vacuum cleaning		<ul style="list-style-type: none"><li>• 100% Visual white-light inspection</li><li>• 100% Visual UV-light inspection</li></ul>				Form 01
Cleanliness Acceptance of Test-System	-----		-----		Complete & approved inspection documentation	-----	Form 03 Part A
Pre-Commissioning of Test-System	Blowing out with oil free dry air or nitrogen		• 100% Visual white-light inspection where possible		Equivalent to prior to Installation sequence	-----	Form 03 Part B

<sup>1)</sup> Cleaning activity shall take place either after material receiving inspection of piping parts or after prefabricated piping spool fabrication.

<sup>2)</sup> In case valves are identified contaminated with oil/grease (as delivered), these shall be put ON HOLD and the further proceeding shall be agreed with COMPANY.If acceptance criteria cannot be met at all LINDE shall be contacted for clarification.

**Table 2: Cleaning and inspection of process piping for cleaning class S3 and S4**

Fabrication sequence / Components	Cleaning		Inspection		Acceptance criteria See also LS 141-76	Preser- vation	Docum- entation
	Ferritic steels	Austenitic steels, Aluminium	Ferritic steels	Austenitic steels, Aluminium			
Material Receiving Valves	-----		• 100% Visual white-light inspection <sup>2)</sup>		No visible traces of: • rust and loose scale, weld spatters, particles dust, fibres or other foreign materials. • moisture, liquids  Accumulation, i.e. a local concentration of particles of any size is not acceptable	Protection of openings with plastic caps/plugs, resp. plastic foil and tape	Form 01
Prefabrication Piping parts (pipes, fittings, etc.) Piping spools	-----		-----				-----
Prior to Installation Piping spools and valves	Blowing out with oil free, dry air or nitrogen (requires strict observance of safety regulations) and/or vacuum cleaning		• 100% Visual white-light inspection				Form 01
Cleanliness Acceptance of Test-System	-----		-----		Complete & approved inspection documentation	-----	Form 03 Part A
Pre-Commissioning of Test-System	Blowing out with oil free dry air or nitrogen		• 100% Visual white-light inspection where possible		Equivalent to prior to Installation sequence	-----	Form 03 Part B
<sup>1)</sup> Cleaning activity shall take place either after material receiving inspection of piping parts or after prefabricated piping spool fabrication.							
<sup>2)</sup> In case valves are identified contaminated (as delivered), these shall be put ON HOLD and the further proceeding shall be agreed with COMPANY.If acceptance criteria cannot be met at all LINDE shall be contacted for clarification.							


**Table 3: Cleaning and inspection of flat bottom tanks for oxygen service<sup>1)</sup>**

Fabrication sequence / Components	Cleaning	Inspection	Acceptance criteria See also LS 141-76	Preservation
<b>After hydrostatic test</b> Inside inner tanks of flat bottom tanks	Inner Tank: High pressure steam cleaning / degreasing (degreasing agent may be required), Alternatively pickling and passivation.	<ul style="list-style-type: none"> <li>• 100% Visual white-light inspection</li> <li>• 100% Visual UV-light inspection</li> </ul>	No visible traces of: <ul style="list-style-type: none"> <li>• organic material such as oil, grease, paint, etc.</li> <li>• cleaning agents, detergents</li> <li>• rust and loose scale, weld spatters, particles dust, fibres or other foreign material. No accumulation of any particles</li> <li>• moisture, liquids</li> </ul> Accumulation, i.e. a local concentration of particles of any size is not acceptable. UV-light inspection shall not reveal any indications of oil/grease.	Sealing against ingress of any foreign particles and liquids
<sup>1)</sup> If process piping is included in the scope of flat bottom tank refer to Table 1.				

Annex A  
(informative)  
**Overview of Forms**

Form	Titel	Issue	Document name
Form 01	Cleanliness of surfaces in air separation plants and components – Process piping for oxygen service at construction sites - Cleanliness acceptance report	06 / 09.2016	LS 141-74 Part 13 Form 01
Form 02	Cleanliness of surfaces in air separation plants and components – Flat bottom tanks for oxygen service at construction sites - Cleanliness acceptance report	04 / 09.2016	LS 141-74 Part 13 Form 02
Form 03	Cleanliness of surfaces in air separation plants and components - Process piping and tanks for oxygen service at construction sites - Confirmation of Compliance	02 / 09.2016	LS 141-74 Part 13 Form 03




	<p>Cleanliness of surfaces in air separation plants and components          Process piping for oxygen service at construction sites</p> <p><b>Cleanliness acceptance report</b></p>	<p>LINDE STANDARD</p> <p><b>LS 141-74</b></p> <p>Part 13 Form 01</p>
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Issue 06/09.2016

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Project No, Code:																						
CONTRACTOR:										<input type="checkbox"/> Specification: <span style="float: right;"><input type="checkbox"/> LS 141-74 Part 13</span>												
Line No.	Sheet No.	Spool No.	Valve No.	Constr. Status			Cleaning				Inspection				Preser- vation		A - accept R - reject	Checked				Remarks
				Mat. receiving	Prefabrication	Prior installation	Grit blasting	High pr. clean.	Pig cleaning	Blowing out	White-Visual	UV-light	Wipe test / Pig	Endoscopy	End protection	Other		CONTRACTOR		COMPANY		
																		Date	Signature	Date	Signature	

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	Cleanliness of surfaces in air separation plants and components Flat bottom tanks for oxygen service at construction sites  Cleanliness acceptance report	LINDE STANDARD  <b>LS 141-74</b> Part 13 Form 02
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Issue 04/09.2016

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Project No:	Project Code:
CONTRACTOR:	<input type="checkbox"/> Specification: <input type="checkbox"/> LS 141-74 Part 13
Equipment No:	Storage Fluid:

	Constr. Status		Cleaning					Inspection		Preservation <sup>1)</sup> (define)	A - accept R - reject	Remarks	Checked after pressure test				
	Installation	After Hydrostatic Test	High pressure cleaning	Pickling and Passivation	Other (define)	Blowing out	Visual white-light	UV-light	Contractor				Company				
									Date				Signature	Date	Signature		
In-side inner tank																	
Out-side inner tank																	

<sup>1)</sup> Preservation methods:

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	CONTRACTOR	COMPANY	CLIENT
Name			
Date			
Signature			

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LS 141-74.T13-F02 (EN)

	<p>Cleanliness of surfaces in air separation plants and components</p> <p>Process piping and tanks for oxygen service at construction sites</p> <p><b>Confirmation of Compliance</b></p>	<p>LINDE STANDARD</p> <p><b>LS 141-74</b></p> <p>Part 13 Form 03</p>
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Issue 02/09.2016

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Project No:	Project Code:
CONTRACTOR:	<input type="checkbox"/> Specification: <input type="checkbox"/> LS 141-74 Part 13
Reference Document:	
Scope of Work / Test System:	

#### **PART A – AFTER CLEANLINESS ACCEPTANCE**

It is hereby certified, that following item(s):

- ☐ process piping system for oxygen service and related components/parts
- ☐ flat bottom tank for oxygen service

erected under responsibility of CONTRACTOR and in compliance with the requirements of LS 141-74 Part 13, without deviations.

\_\_\_\_\_  
CONTRACTOR QA/QC

\_\_\_\_\_  
Place, Date

\_\_\_\_\_  
Signature

	CONTRACTOR	COMPANY	CLIENT
Name			
Date			
Signature			

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LS 141-74.T13-F03 (EN)

**PART B – AFTER PRE-COMMISSIONING**

It is hereby certified, that following item(s):

- ☐ process piping system for oxygen service and related components/parts
- ☐ flat bottom tank for oxygen service

pre-commissioned under responsibility of COMPANY and in compliance with the requirements of LS 141-74 Part 13, without deviations.

\_\_\_\_\_  
COMPANY

\_\_\_\_\_  
Place, Date

\_\_\_\_\_  
Signature

	CONTRACTOR	COMPANY	CLIENT
Name			
Date			
Signature			